MOTORISTICA DEL TRASPORTO MARITTIMO

Luca Boaro
Ship Power
Flow & Gas Solutions
Fuel Gas Handling
Wärtsilä Italia S.p.A.
E-mail: luca.boaro@wartsila.com
WÄRTSIÄ GAS FUEL TECHNOLOGIES

1987
GAS-DIESEL (GD)
4-STROKE
HIGH PRESSURE

1992
SPARK-IGNITION
GAS (SG)
4-STROKE
LOW PRESSURE

1995
DUAL FUEL (DF)
4-STROKE
LOW PRESSURE

2013
DUAL FUEL (DF)
2-STROKE
LOW PRESSURE

DESIGN PHILOSOPHY
4-STROKE DF PORTFOLIO

**WÄRTSILÄ 20DF**

0.5 - 1.8 MW

> 50 ENGINES 20DF

**WÄRTSILÄ 34DF**

3.0 – 10.0 MW

> 110 ENGINES 34DF

**WÄRTSILÄ 50DF**

5.8 - 17.5 MW

> 600 ENGINES 50DF

**WÄRTSILÄ 46DF**

6.2 - 18.3 MW

**WÄRTSILÄ 31DF**

**APPLICATIONS**

- LNG Carriers
- Cruise ships
- RO-RO/PAX
- Ferries
- Large Offshore Units
- Aux. engines with W34DF & W50DF
- Small LNG / CNG vessel
- Small cargo vessels
- Supply vessel
- Offshore application & Production
- Aux. engines with W50DF
- Tugs
- LNG Carriers
- Cruise ships
- RO-RO/PAX
- Ferries
- Large Offshore Units
- Aux. engines with W34DF & W50DF
- Small LNG / CNG vessel
- Small cargo vessels
- Supply vessel
- Offshore application & Production
- Aux. engines with W50DF
- Tugs

**USES**

- Small LNG / CNG vessel
- Small cargo vessels
- Supply vessel
- Offshore application & Production
- Aux. engines with W50DF
- Tugs

**11 June 2015**
The Wärtsilä 31 is the first of a new generation of medium speed engines, designed to set a new benchmark in efficiency and overall emissions performance.
THE LOWEST FUEL CONSUMPTION OF ANY 4-STROKE ENGINE

Specific fuel oil consumption at 85% load [g/kWh] *)

- WÄRTSILÄ 31

*) with 5% tolerance and without pumps
Source: respective home pages & Product manuals
**OPERATING PRINCIPLE - GAS (DF) AND DIESEL**

Gas mode:
- Otto principle
- Low-pressure gas admission
- Pilot diesel injection

Diesel mode:
- Diesel principle
- Diesel injection

Intake of air and gas
compression of air and gas
ignition by pilot diesel fuel

Intake of air
compression of air
injection of diesel fuel
Wärtsilä Dual Fuel engines are real GAS engines with flexibility

- Can start in gas mode
- Can stop in gas mode
- Can operate on low load in gas mode
- Can idle in gas
- Can change between gas and liquid fuel on the go
- Can operate on one lube oil for all fuels
- Can operate on cheapest fuel available
- Increased time between overhaul
- Increased components lifetime
LNG SHIP - EMISSIONS

IMO Tier III compliant

SOx compliant

EPA compliant

Dual-Fuel engine in gas mode

- CO₂: -25%
- NOx: -85%
- SOx: -99%
- Particulates: -99%

Diesel engine

Emission values [%]

100
90
80
70
60
50
40
30
20
10
0

11 June 2015
Dual Fuel engine can transfer **instantly** to diesel mode at any load.

Safety and flexibility
DF LOADING TEST 0–100%, GAS OPERATION

Frequency variation ~2%
DF redundancy **proves** even in full power ramp-up an sudden failure in the gas system does not compromise safety.
MDO TO GAS AT 80% LOAD

Speed
Gas pressure
Load
Receiver pressure
Pilot fuel pressure
Diesel actuator
>1,300 engines → >12,000,000 running hours
Dual Fuel engines

LNGPac™

Gas Valve Unit (GVU)

LNG Bunker Station
LNGPac™: **complete** fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station with connections to shore
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station with connections to shore
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
LNGPac™: complete fuel gas handling solution for LNG fuelled ships

- IMO Type C LNG fuel tank
  - Design pressure up to 9 bar g
- Tank connection space
  - Process skid (valves, evaporators & instruments)
- Bunker station with connections to shore
- Heating Media system design/components
- Safety and control system
- Operating manuals and class approval
1. Open pressure control valve
2. LNG flow by the hydrostatic pressure into the vaporizer
3. LNG is vaporized and gas is returned to the tank
1. The “master gas valve” is opened (pneumatic actuated valve with manual override)

2. LNG is forced by the tank pressure through the product evaporator and instantly evaporated. Gas flows to the GVU...
1. The “master gas valve” is opened (pneumatic actuated valve with manual override)

2. LNG is forced by the tank pressure through the product evaporator and instantly evaporated. Gas flows to the GVU

GVU-ED™
(encrypted design) Gas Valve Unit
LNGPAC™ - COLD RECOVERY
Energy recovered: abt. 35 kW for each MW of the DF Engine(s) installed
<table>
<thead>
<tr>
<th>Project</th>
<th>Client</th>
<th>Total installed engine power</th>
<th>Classification</th>
<th>Nbr of vessels</th>
<th>Total installed LNG storage capacity</th>
<th>Nbr of tanks</th>
<th>Year of delivery</th>
<th>SW/DW</th>
<th>In operation</th>
<th>Under construction</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>25,000DWT Chemical Tanker - “Bit Viking”</td>
<td>Tarbit (SE)</td>
<td>11,400 kW</td>
<td>LR</td>
<td>1</td>
<td>1000</td>
<td>2</td>
<td>2011</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>Conversion</td>
</tr>
<tr>
<td>RePax Ferry - “Viking Grace”</td>
<td>Viking Line (SE)</td>
<td>30,400 kW</td>
<td>LR</td>
<td>1</td>
<td>400</td>
<td>2</td>
<td>2012</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Platform Supply Vessel - “Harvey Energy”</td>
<td>Harvey Gulf Marine (USA)</td>
<td>7,530 kW</td>
<td>ABS</td>
<td>1</td>
<td>295</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building. 1st delivery out of series of 6 vessels</td>
</tr>
<tr>
<td>Platform Supply Vessel</td>
<td>Harvey Gulf Marine (USA)</td>
<td>7,530 kW</td>
<td>ABS</td>
<td>5</td>
<td>295</td>
<td>1</td>
<td>2015/2016</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Platform Supply Vessel VS4410DF - “Rem Eir”</td>
<td>Remøy Shipping AS (NO)</td>
<td>8,216 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>230</td>
<td>1</td>
<td>-</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Platform Supply Vessel VS4410DF - “Siem Symphony”</td>
<td>Siem Offshore Rederi AS (NO)</td>
<td>8,216 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>230</td>
<td>1</td>
<td>2015/2016</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building at different shipyards</td>
</tr>
<tr>
<td>Platform Supply Vessel</td>
<td>Siem Offshore Rederi AS (NO)</td>
<td>8,216 kW</td>
<td>DNV-GL</td>
<td>3</td>
<td>230</td>
<td>1</td>
<td>2015/2016</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building at different shipyards</td>
</tr>
<tr>
<td>Passenger &amp; Cargo Ferry - “F.A. Gauthier”</td>
<td>Société des Travesieres du Québec (CA)</td>
<td>11,520 kW</td>
<td>LR</td>
<td>1</td>
<td>560</td>
<td>2</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Double-end Car/Passenger Ferry - “Fjord 1”</td>
<td>Torghatten Nord (NO)</td>
<td>2,430 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>50</td>
<td>1</td>
<td>2012/2013</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>RePax Ferry</td>
<td>Torghatten Nord (NO)</td>
<td>2430/5280 kW</td>
<td>DNV-GL</td>
<td>4</td>
<td>150</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Passenger &amp; Car Ferry - “Ostfjordland”</td>
<td>AG Ems (DE)</td>
<td>2,560 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>45</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>Conversion</td>
</tr>
<tr>
<td>ReRoPax Ferry</td>
<td>Société des Travesieres du Québec (CA)</td>
<td>5,280 kW</td>
<td>LR</td>
<td>2</td>
<td>110</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Passenger &amp; Car Ferry</td>
<td>AG Ems (DE)</td>
<td>3,330 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>53</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>ReRo Cargo Cargo Ferry</td>
<td>Seaspan Ferries Corporation (CA)</td>
<td>8,640 kW</td>
<td>BV</td>
<td>2</td>
<td>200</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Fish feeder - “NAV Haydal”</td>
<td>NSK Shipping (NO)</td>
<td>1,620 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>90</td>
<td>1</td>
<td>2012</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>ReRo Cargo Vessel</td>
<td>Sea Cargo (NO)</td>
<td>5,250 kW</td>
<td>DNV-GL</td>
<td>2</td>
<td>228</td>
<td>2</td>
<td>7</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building - delayed</td>
</tr>
<tr>
<td>ReRo Trailer Ship - “ORCA Class”</td>
<td>Totem Ocean Trailer Express (USA)</td>
<td>45,600kW</td>
<td>ABS</td>
<td>2</td>
<td>2200</td>
<td>2</td>
<td>2015/2016</td>
<td>SW</td>
<td>X</td>
<td></td>
<td>Conversion</td>
</tr>
<tr>
<td>Harbour Tug</td>
<td>Dry Dock World Dubai (UAE)</td>
<td>3,330 kW</td>
<td>Tasneef</td>
<td>1</td>
<td>25</td>
<td>1</td>
<td>2015</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>RePax RoRo Cargo Ferry</td>
<td>BC Ferries (CA)</td>
<td>4,260 kW</td>
<td>LR</td>
<td>3</td>
<td>140</td>
<td>1</td>
<td>2016/2017</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building. Tank supplied by shipyard</td>
</tr>
<tr>
<td>RePax Passenger &amp; Cargo Vessel</td>
<td>Rederi AB Gotland (SE)</td>
<td>53,136 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>570</td>
<td>2</td>
<td>2016</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Product Tanker</td>
<td>Transport Desgagnes Inc. (CA)</td>
<td>10,630 kW</td>
<td>BV</td>
<td>2</td>
<td>620</td>
<td>2</td>
<td>2015</td>
<td>SW</td>
<td>X</td>
<td></td>
<td>New building (consortium)</td>
</tr>
<tr>
<td>Harbour Tug</td>
<td>Ostensjo Rederi (NO)</td>
<td>6,000 kW</td>
<td>BV</td>
<td>3</td>
<td>33</td>
<td>1</td>
<td>2016</td>
<td>DW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td>Multipurpose Vessel - “Living Stone”</td>
<td>DEMIE (BE)</td>
<td>14,400 kW</td>
<td>DNV-GL</td>
<td>1</td>
<td>1260</td>
<td>2</td>
<td>2017</td>
<td>SW</td>
<td>X</td>
<td></td>
<td>New building</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>14808</td>
<td>52</td>
<td></td>
<td>12</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** SW = single-shell tank, DW = double-shell tank
Vessel: 25000DWT Chemical Tanker – "Bit Viking"

Owner: Tarbit (Sweden)
Yard: STX (Finland)
Number of vessels: 1 (conversion, year built 2007)
Classification: DNV-GL
Delivery: 2011

Main vessel characteristics:
Length: 177 m
Speed: 15.0 kts
Deadweight: 25000 DWT

Wärtsilä scope of supply:

- 2x LNGPac™ 500m³
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space
  - Auxiliary room
  - 2x Bunkering Station, 400m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)

- 2x 6L50DF (4S, 5700kW)
### Vessel: Ropax Ferry – "Viking Grace"

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Viking Line (Sweden)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>STX (Finland)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>LR</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2013</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

- **Length:** 218 m
- **Speed:** 22.0 kts
- **Passengers / lane mtr:** 2800 / 1775 m

### Wärtsilä scope of supply:

- **2x LNGPac™ 200m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space
  - Auxiliary room
  - 1x Bunkering Station, 400m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (skid)
  - Cold Recovery System

- **4x 8L50DF (4S, 7600kW)**
**Vessel: Platform Supply Vessel**

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Harvey Gulf Marine (USA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Trinity Shipyards (USA)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>6 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>ABS / USCG</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2014/2015</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

| Length:               | 95 m                     |
| Speed:                | 14.0 kts                 |
| Deadweight / deck:    | 5400 DWT / 974 m²        |

**Wärtsilä scope of supply:**

- **1x LNGPac™ 295m³**
  - Horizontal, double-shell tank with vacuum-MLI insulation + Tank Connection Space
  - 1x Bunkering Station, 200m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)

- **3x 6L34DF (4-stroke, 2510 kW)**
- **2x Steerable Thrusters**
- **2x Transverse Thrusters**
- **Integrated Automation System & Power Management System**
# Vessel: Passenger & Cargo Vessel

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Société des Traversieres du Québec (Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Fincantieri (Italy)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>LR</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2014</td>
</tr>
</tbody>
</table>

### Main vessel characteristics:

<table>
<thead>
<tr>
<th>Length:</th>
<th>130 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>20.0 kts</td>
</tr>
<tr>
<td>Passengers:</td>
<td>800</td>
</tr>
</tbody>
</table>

---

### Wärtsilä scope of supply:

- **2 x LNGPac™ 280m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space
  - 1x Bunkering Station, 200m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)
- **2x 12V34DF (4-stroke 5760 kW)**
Wärtsilä scope of supply:

- **1x LNGPac™ 45m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space
  - 1x Bunkering Station, 40m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (skid)
  - Cold Recovery System
  - LNG fuel supply to 3x high speed single-gas engines
  - LNG fuel supply to 1x gas fired boiler

- **2x 6L20DF (4-stroke, 1280 kW)**

**Vessel: Passenger & Car Ferry – "MS Ostfriesland"**

<table>
<thead>
<tr>
<th>Owner</th>
<th>AG Ems (Germany)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>BVT Brenn- und Verformtechnik GmbH (Germany)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (conversion)</td>
</tr>
<tr>
<td>Classification:</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2015</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

- **Length:** 94 m
- **Passengers / cars:** 1200 / 70
- **Speed:** 16.0 kts
Vessel: RoRo Trailer Ship - "Orca Class"

Owner: Totem Ocean Trailer Express (USA)
Yard: TBD
Number of vessels: 2 (conversion)
Classification: ABS
Delivery: 2015/2016

Main vessel characteristics:
Length: 256 m
Speed: 24.0 knots
Cargo capacity: 600 FEU, 200 cars, 33445 m² deck

Wärtsilä scope of supply:

- **2x LNGPac™ 1100 m³**
  - Horizontal, single-shell, PUR insulated tank & cryogenic pumps
  - Fuel Gas Treatment Skid, open type
  - 1x Bunkering Station, 500 m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)
  - LNG fuel supply to 1x gas fired boiler

- **4x 12V50DF (4S, 11400 kW)**
### References

#### Vessel: Harbour Tug

<table>
<thead>
<tr>
<th>Owner</th>
<th>Dry Dock World Dubai (United Arab Emirates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Dry Dock World Dubai (United Arab Emirates)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>Tasneef</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2015</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length</th>
<th>30 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towing capacity</td>
<td>-</td>
</tr>
<tr>
<td>Ship type</td>
<td>Harbour Tug</td>
</tr>
</tbody>
</table>

#### Wärtsilä scope of supply:

- **1x LNGPac™ 25m³**
  - Horizontal double-shell tank, vacuum insulated with perlite + Tank Connection Space
  - Integrated Engine Gas Valve Units (GVU’s) inside TCS
  - 1x Bunkering Station, 50 m³/hr
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, loose components)

- **2x W9L20DF (4S, 1665 kW)**
- **2x Steerable Thruster**
SYSTEM INTEGRATION
THANK YOU!

Luca Boaro
Ship Power
Flow & Gas Solutions
Fuel Gas Handling
Wärtsilä Italia S.p.A.
E-mail: luca.boaro@wartsila.com
www.wartsila.com
## Wärtsilä 2-Stroke Dual-Fuel Engines

<table>
<thead>
<tr>
<th>Engine</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wärtsilä RT-flex50DF</td>
<td>99 - 124</td>
</tr>
<tr>
<td>Wärtsilä X52DF</td>
<td>82 - 105</td>
</tr>
<tr>
<td>Wärtsilä X62DF</td>
<td>80 - 103</td>
</tr>
<tr>
<td>Wärtsilä X72DF</td>
<td>69 - 89</td>
</tr>
<tr>
<td>Wärtsilä X82DF</td>
<td>65 - 84</td>
</tr>
<tr>
<td>Wärtsilä X92DF</td>
<td>70 - 80</td>
</tr>
</tbody>
</table>
Vessel: Platform Supply Vessel VS4411DF

Owner: Siem Offshore Rederi AS (Norway)
Yard: Hellesoy SY (Norway), Remontowa SY (Poland)

Number of vessels: 4 (new building)
Classification: DNV-GL
Delivery: 2014-2016

Main vessel characteristics:
Length: 89 m
Speed: 14.8 kts
Deadweight / deck area: 5500 DWT / 980 m²

Wärtsilä scope of supply:

- **1x LNGPac™ 230m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space (TCS) with integrated Air Lock
  - Auxiliary room
  - Integrated Engine Gas Valve Units (GVU’s) into TCS
  - 1x Bunkering Station, 100m³/ hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)
- **2x 6L34DF (4-stroke, 2700 kW)**
- **2x 8L20DF (4-stroke, 1408 kW)**
- **Ship Design**
**Vessel: Platform Supply Vessel VS4410DF - "Rem Eir"**

- **Owner:** Remøy Shipping AS (Norway)
- **Yard:** Kleven Verft Shipyard (Norway)
- **Number of vessels:** 1 (new building)
- **Classification:** DNV
- **Delivery:** 2014

**Main vessel characteristics:**

- **Length:** 93 m
- **Speed:** 14.7 kts
- **Deadweight / deck area:** 5770 DWT / 1090 m²

---

**Wärtsilä scope of supply:**

- **1x LNGPac™ 230m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space (TCS) with integrated Air Lock
  - Auxiliary room
  - Integrated Engine Gas Valve Units (GVU’s) into TCS
  - 1x Bunkering Station, 100m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)

- **2x 6L34DF (4-stroke, 2700 kW)
- **2x 8L20DF (4-stroke, 1408 kW)
- **Ship Design**
### Vessel: RO/RO Trailer Cargo Ferry

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Seaspan Ferries Corporation (Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Sedef Shipyard (Turkey)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>2 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>BV</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2015/2016</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

| Length:  | 150 m         |
| Speed:   | -             |
| Trailers:| 59            |

### Wärtsilä scope of supply:

- **1x LNGPac™ 200m³**
  - Horizontal double-shell tank, vacuum insulated with perlite + Tank Connection Space with integrated Air Lock
  - 1x Bunkering Station, 100 m³/h
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, loose components)

- **2 x W9L34DF (4S, 4320kW)**
**Vessel: Fish Feeder**

<table>
<thead>
<tr>
<th>Owner</th>
<th>NSK (Norway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Tersan Shipyard (Turkey)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery</td>
<td>2012</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length:</th>
<th>70 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>14.0 kts</td>
</tr>
<tr>
<td>Gross Tonnage:</td>
<td>2650 ton</td>
</tr>
</tbody>
</table>

**Wärtsilä scope of supply:**

- **1x LNGPac™ 90m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation
  - 1x Bunkering Station
- **1x RR C26:33L6PG (4S-SG, 1620 kW)***
## Vessel: RoRo Pax Ferry

<table>
<thead>
<tr>
<th>Owner</th>
<th>Société des Traversières du Québec (Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Chantier Davie Canada Inc. (Canada)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>2</td>
</tr>
<tr>
<td>Classification:</td>
<td>LR</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2014</td>
</tr>
</tbody>
</table>

### Main vessel characteristics:

<table>
<thead>
<tr>
<th>Length</th>
<th>92 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>-</td>
</tr>
<tr>
<td>Passengers / cars:</td>
<td>432 / 115</td>
</tr>
</tbody>
</table>

## Wärtsilä scope of supply:

- **1x LNGPac™ 110m³**
  - Horizontal, double-shell tank with multi-layer insulation + Tank Connection Space
  - 1x Bunkering Station, 40m³/hr
  - Process Control Automation & Safety System (integrated part of IAS)
  - Heating Media System (glycol water, skid)
  - Nitrogen generator

- **2x 9L20DF (4S, 1584 kW)**
- **2x 6L20DF (4S, 1056 kW)**
- **Electrical main systems, Integrated Automation System & Power Management System**
- **Integrated Bridge System – 3C**
- **On-site management**

---

May 2015
Wärtsilä LNGPac - Reference List
**Wärtsilä scope of supply:**

- **2x LNGPac™ 228m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation
  - 1x Bunkering Station

- **1x RR B35:40V12PG (4S-SG, 5280 kW)**

**Vessel: RoRo Cargo Vessel**

<table>
<thead>
<tr>
<th>Owner</th>
<th>Sea Cargo (Norway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Bharati Shipyard (India)</td>
</tr>
<tr>
<td>Number of vessels</td>
<td>2 (new building)</td>
</tr>
<tr>
<td>Classification</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery</td>
<td>?</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length</th>
<th>129 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>20.0 kts</td>
</tr>
<tr>
<td>Gross Tonnage</td>
<td>1300 tonnes</td>
</tr>
</tbody>
</table>
# Vessel: Torghatten - RoPax Ferry

<table>
<thead>
<tr>
<th>Owner</th>
<th>Torghatten Nord A.S. (Norway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Remontowa (Poland)</td>
</tr>
<tr>
<td>Number of vessels</td>
<td>4 (new building)</td>
</tr>
<tr>
<td>Classification</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery</td>
<td>2012/2013</td>
</tr>
</tbody>
</table>

## Main vessel characteristics:

- **Length x Width (m):** 93.0
- **Passengers / cars:** 390 / 120
- **Speed:** 17.0 / 19.0 kts

## Wärtsilä scope of supply:

- **1x LNGPac™ 150m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation
  - 1x Bunkering Station

- **Ferry 1-2: 1x RR C26:33L9PG (4S-SG, 2430 kW)**
- **Ferry 3-4: 1x RR B35:40V12PG (4S-SG, 5280 kW)**
Wärtsilä scope of supply:

- **1x LNGPac™ 50m³**
  - Horizontal, double-walled tank with vacuum-perlite insulation
  - 1x Bunkering Station

- **1 x RR C26:33L9AG (4S-SG, 2430kW)**

**Vessel: Double-end Passenger & Car Ferry - "Tresfjord"**

<table>
<thead>
<tr>
<th>Owner</th>
<th>Fjord 1 Ferries (NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard</td>
<td>Western Shipyard (NO)</td>
</tr>
<tr>
<td>Number of vessels</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery</td>
<td>2012</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

- **Length:** 130 m
- **Speed:** 20,0 kts
- **GT:** 3423 tonnes
### Vessel: RoRo Pax Ferry – "ICF type"

<table>
<thead>
<tr>
<th>Owner:</th>
<th>BC Ferries (Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Remontowa Shipbuilding S.A. (Poland)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>3 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>LR</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2016/2017</td>
</tr>
</tbody>
</table>

### Main vessel characteristics:

- **Length:** 107 m
- **Speed:** -
- **Passengers / cars:** 600 / 145

---

### Wärtsilä scope of supply:

- **1x LNGPac™ 130m³**
  - Tank design for horizontal, double-shell tank with vacuum-perlite insulation
  - Tank Connection Space, including equipment based on RC technology (no need for glycol-water)
  - Integrated Engine Gas Valve Units (GVU’s) inside TCS
  - 1x Bunkering Station, 80m³/hr, including vapour return
  - Process Control Automation & Safety System
  - LNG fuel supply to 1x gas fired boiler

- **3x 8L20DF (4S, 1420kW)**
- **Low Loss Concept (LLC) electrical system, thruster drives, Integrated Automation & Power Management System**
### Vessel: RoPax Passenger & Car Ferry

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Rederi AB Gotland (Sweden)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Guangzhou Shipyard International (China)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2016</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length:</th>
<th>200 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>29.0 kts</td>
</tr>
<tr>
<td>Passengers / Lane:</td>
<td>1650 / 1750 m</td>
</tr>
</tbody>
</table>

### Wärtsilä scope of supply:

- **2x LNGPac™ 285m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space with integrated Air Lock
  - 2x Bunkering Station, 400m³/hr, including vapour return
  - Process Control Automation & Safety System
  - 2x Heating Media System (skid)
  - 2x Cold Recovery System
  - LNG fuel supply to 2x gas fired boiler

- **4x 12V50DF (4S, 11700 kW)**
- **4x 9L20DF (4S, 1584 kW)**
- **2x CPP, Gear Box & Rudder**
- **2x Tunnel Thruster**
- **Compact Silencer System**
- **Ballast Water Management**
- **Oily Water Separator**
**Vessel: Product Tanker**

<table>
<thead>
<tr>
<th>Owner:</th>
<th>Transport Desgagnes Inc. (Canada)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>Besiktas Shipyard (Turkey)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>2 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>BV</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2015</td>
</tr>
</tbody>
</table>

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length:</th>
<th>135 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>-</td>
</tr>
<tr>
<td>Cargo capacity:</td>
<td>15000 DWT</td>
</tr>
</tbody>
</table>

**Wärtsilä scope of supply:**

- **2x LNGPac™ 310m³**
  - Horizontal, single-shell tank with PUR insulation (Consortium)
  - 1x Fuel Gas Treatment Skid, open type
  - 2x Bunkering Station, 220m³/hr, including vapour return
  - Process Control Automation & Safety System
  - Heating Media System (glycol water, skid)
  - LNG fuel supply to 2x gas fired boiler

- **1x 5RTFlex50DF (2S, 5450 kW)**
- **2x 8L20DF (4S, 1480 kW)**
- **2x 6L20DF (4S, 1110 kW)**
## Vessel: Ostensjo Rederi – Harbour tug

<table>
<thead>
<tr>
<th><strong>Owner</strong></th>
<th>Ostensjo Rederi (Norway)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yard</strong></td>
<td>Astilleros Gondan (Spain)</td>
</tr>
<tr>
<td><strong>Number of vessels</strong></td>
<td>3 (new building)</td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td>BV</td>
</tr>
<tr>
<td><strong>Delivery</strong></td>
<td>2016</td>
</tr>
</tbody>
</table>

### Main vessel characteristics:

<table>
<thead>
<tr>
<th><strong>Length</strong></th>
<th>40 m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Towage capacity</strong></td>
<td>100 tons BP</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Harbour towage</td>
</tr>
</tbody>
</table>

## Wärtsilä scope of supply:

1. **1x LNGPac™ 33m³**
   - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space with integrated Air Lock
   - Integrated Engine Gas Valve Units (GVU’s) inside TCS
   - 1x Bunkering Station, 50m³/hr
   - Process Control Automation & Safety System
   - Heating Media System (glycol water, loose components)

2. **2 x 6L34DF (4S, 3000 kW)**
**Wärtsilä scope of supply:**

- **2x LNGPac™ 630m³**
  - Horizontal, single-shell tank with PUR insulation
  - 1x Fuel Gas Treatment Skid, enclosed type with integrated Air Lock
  - 2x Bunkering Station, 220m³/hr, including vapour return
  - Process Control Automation & Safety System (high redundancy execution)
  - Heating Media System (glycol water, skid)
  - LNG fuel supply to 1x gas fired boiler

**Main vessel characteristics:**

<table>
<thead>
<tr>
<th>Length:</th>
<th>TBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed:</td>
<td>TBA</td>
</tr>
<tr>
<td>Purpose:</td>
<td>Cable Lay, Fall-pipe &amp; rock dumping, installation &amp; subsea</td>
</tr>
</tbody>
</table>

**Vessel: Multipurpose Vessel – “Living Stone”**

<table>
<thead>
<tr>
<th>Owner:</th>
<th>DEME (Belgium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard:</td>
<td>LaNaval Shipyard (Spain)</td>
</tr>
<tr>
<td>Number of vessels:</td>
<td>1 (new building)</td>
</tr>
<tr>
<td>Classification:</td>
<td>DNV-GL</td>
</tr>
<tr>
<td>Delivery:</td>
<td>2017</td>
</tr>
</tbody>
</table>

**References**

- May 2015
- Wärtsila LNGPac - Reference List

---

*Image: Multipurpose Vessel “Living Stone” with Wärtsilä equipment.*
**Wärtsilä scope of supply:**

- **1x LNGPac™ 53m³**
  - Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space
  - 1x Bunkering Station, 40 m³/hr
  - Process Control Automation & Safety System
  - Heating Media System (skid)
  - Cold Recovery System
  - LNG fuel supply to 4x high speed single-gas engine
  - LNG fuel supply to 1x gas fired boiler

- **2x 9L20DF (4-stroke, 1665 kW)**

<table>
<thead>
<tr>
<th>Vessel: Passenger Ferry</th>
<th>Wärtsilä scope of supply:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Owner:</strong> AG Ems (Germany)</td>
<td><strong>1x LNGPac™ 53m³</strong></td>
</tr>
<tr>
<td><strong>Yard:</strong> Fassmer (Germany)</td>
<td><strong>Horizontal, double-shell tank with vacuum-perlite insulation + Tank Connection Space</strong></td>
</tr>
<tr>
<td><strong>Number of vessels:</strong> 1 (new building)</td>
<td><strong>1x Bunkering Station, 40 m³/hr</strong></td>
</tr>
<tr>
<td><strong>Classification:</strong> DNV-GL</td>
<td><strong>Process Control Automation &amp; Safety System</strong></td>
</tr>
<tr>
<td><strong>Delivery:</strong> 2015</td>
<td>** Heating Media System (skid)**</td>
</tr>
<tr>
<td><strong>Main vessel characteristics:</strong></td>
<td><strong>Cold Recovery System</strong></td>
</tr>
<tr>
<td><strong>Length:</strong> 83 m</td>
<td><strong>LNG fuel supply to 4x high speed single-gas engine</strong></td>
</tr>
<tr>
<td><strong>Speed:</strong> 19.0 kts</td>
<td><strong>LNG fuel supply to 1x gas fired boiler</strong></td>
</tr>
<tr>
<td><strong>Passengers:</strong> 1200</td>
<td></td>
</tr>
</tbody>
</table>

**References**

**Vessel:** Passenger Ferry

- **Owner:** AG Ems (Germany)
- **Yard:** Fassmer (Germany)
- **Number of vessels:** 1 (new building)
- **Classification:** DNV-GL
- **Delivery:** 2015

**Main vessel characteristics:**

- **Length:** 83 m
- **Speed:** 19.0 kts
- **Passengers:** 1200

**Vessel:** Passenger Ferry

- **Owner:** AG Ems (Germany)
- **Yard:** Fassmer (Germany)
- **Number of vessels:** 1 (new building)
- **Classification:** DNV-GL
- **Delivery:** 2015

**Main vessel characteristics:**

- **Length:** 83 m
- **Speed:** 19.0 kts
- **Passengers:** 1200